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EXPERIMENTS WITH ORTHOPTERA CONCERNING DIURNAL RHYTHM

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Broadly speaking, insects may be grouped as to whether they are diurnal or nocturnal. Possibly all species have at least a trace of diurnal rhythm in their activities but, even where there is a marked rhythm, we have very few accurate data concerning its extent and especially concerning its persistence under changed conditions.

The data presented here were obtained quite simply by means of a homemade recording apparatus. The insects to be tested were put in a cage having a small compartment at each end. These compartments were connected by a narrow runway and in the middle of this runway was a delicately counterbalanced treadle. When an insect crossed the treadle the insect's weight depressed the treadle so that wires at the ends of the treadle dipped into mercury, completing an electric circuit through an electromagnet. This magnet pulled aside a recording pen which was otherwise tracing a straight line on adding-machine paper. The paper used was wide enough to accommodate six of these pens and was kept moving at a constant rate by, according to circumstances, either an eight-day spring clockwork or a motor such as is used in electric clocks. The ink reservoir of each pen (both homemade) was of such a size that the supply of ink was sufficient for recording during several days of enforced absence of the experimenter. The movement of the paper was regulated to be about three inches per hour. When the motor clockwork was used the movement of the paper did not appreciably vary but it did vary when the spring clockwork was used. In the latter case, one of the pens was used to mark the hours, being electrically controlled from a more accurate eight-day clock. Unless otherwise stated, only one insect at a time was used in a given cage.

The graphs presented in this connection are made from the accompanying tables. In the tables "average daily activity" is the average number of times the insect crossed the treadle in either direction in a day. The number of days and fractions of a day upon which this average is actually based may be found from the "number of hours recorded" column. This number of days does not always correspond with the

length of the experiment because of occasional trouble with the recording device. For the purpose of presenting the diurnal rhythm data the day is divided into twelve two-hour periods as shown, and the average amount of activity in each period is given as percentages of the average daily activity.

If there were no diurnal rhythm, if the activity were evenly distributed throughout the day, there would, of course, be 8.3 per cent activity in each two-hour period. This 8.3 per cent line of random activity is shown in the graphs as the upper margin of the strip that indicates the conditions of light.

Dense shading in the basal part of a graph indicates darkness at the corresponding period of the day. No shading indicates full illumination. When there was normal transition from daylight to night-darkness and back to daylight this is indicated by a gradual increase and decrease of shading but no attempt has been made to have the degree of shading correspond to the actual amount of light in the case of normal day-night changes of illumination.

The darkness indicated in the experiments with "constant darkness" and with "reversed illumination" was obtained by having the apparatus in a dark room of the cellar of my home. Incidentally, this gave also conditions of practically constant humidity and temperature. At no time did the temperature of this room vary two degrees centigrade within twenty-four hours and rarely more than one degree. "Reversed illumination" was obtained in the cellar by turning on strong electric lights at 8 P.M. and turning them off at 6 A.M. standard time.

Gryllus domesticus

This European House-cricket, now rather widely distributed in America, was being used for another purpose in an apparatus similar to that just described. The following data are, then, in the nature of by-products of the other work.

It will be seen from figure 1 and table 1 that, although nocturnal insects, the activities of this species, whether mature or immature, male or female, take place chiefly between 7 P.M. and midnight, with a definite peak at about 9 P.M.

Figures 2 to 4 and table 1 present three experiments in which we have activity data for the same individuals in normal illumination and in constant darkness, while figure 5 gives similar data for a combination of experiments. Clearly, the normal diurnal rhythm of activity is something which is fixed enough to persist rather definitely in constant

TABLE 1.—CONDENSED STATEMENT OF DATA CONCERNING *GRYLLUS DOMESTICUS*

Experiment	Dates	Light	Average Activity, Per Cent												Average Daily Activity	Number of Hours Recorded
			Noon 2 PM	2 PM 4 PM	4 PM 6 PM	6 PM 8 PM	8 PM 10 PM	10 PM Mid.	Mid. 2 AM	2 AM 4 AM	4 AM 6 AM	6 AM 8 AM	8 AM 10 AM	10 AM Noon		
330 G Immat.	Mch. 30 Apr. 3	N	5.2	0.8	1.4	16.7	46.7	15.6	3.3	4.4	0.3	0.0	0.0	5.6	89.92	84
	Apr. 3 Apr. 12	D	2.3	1.9	0.2	14.3	29.3	21.5	14.3	4.9	8.5	1.2	0.3	1.2	122.96	170
413 G Immat. Males	Apr. 13 Apr. 17	N	8.4	8.4	7.0	21.0	22.9	18.3	6.5	1.2	0.0	0.9	3.3	1.9	53.42	92
413 G Immat. Females	Apr. 13 Apr. 17	N	0.0	1.4	0.0	23.9	38.8	27.5	5.6	0.0	0.0	1.4	0.0	1.4	35.50	92
420 G Males	Apr. 20 Apr. 26	N	1.0	3.4	6.3	23.6	29.5	14.0	9.7	4.3	2.2	0.0	4.3	1.7	41.42	125
420 G Females	Apr. 20 Apr. 26	N	0.6	4.5	3.2	13.5	27.1	21.0	11.3	8.1	3.8	0.5	3.5	2.4	61.94	134
729 G Immat.	July 30 Aug. 1	N	0.0	0.0	0.0	0.8	20.0	25.6	22.4	18.8	10.8	0.0	0.8	0.8	125.00	37
	Aug. 1 Aug. 8	D	7.0	5.2	5.2	8.9	11.5	15.4	13.6	9.2	8.7	3.9	6.0	5.5	135.06	165
723 G Immat.	July 25 Aug. 1	N	5.5	3.5	3.3	4.1	11.7	28.5	18.0	6.0	6.3	1.5	2.4	9.2	61.04	143
	Aug. 1 Aug. 8	D	14.8	9.5	10.3	14.5	13.1	19.5	1.6	5.0	0.6	2.5	2.2	6.6	45.84	156
802 G Immat.	Aug. 2 Aug. 8	D	8.6	12.1	13.1	10.1	14.9	12.5	9.3	6.1	3.7	0.8	1.6	7.3	49.56	114
	Aug. 8 Aug. 13	D	7.7	21.2	14.4	12.5	12.8	2.4	0.0	1.9	12.8	3.9	1.9	8.5	20.78	112

darkness, temperature, and humidity. There is, however, a noticeable tendency to spread the activity into hours in which there was normally very little and this spreading of course decreases the height of the activity peak.

I have not found any satisfactory numerical index of concentration of activity and neither have I been able to calculate the probable error of the position of the peak. My difficulty seems to be to start or stop a curve that is really on a circular base-line, the diurnal cycle of time. One

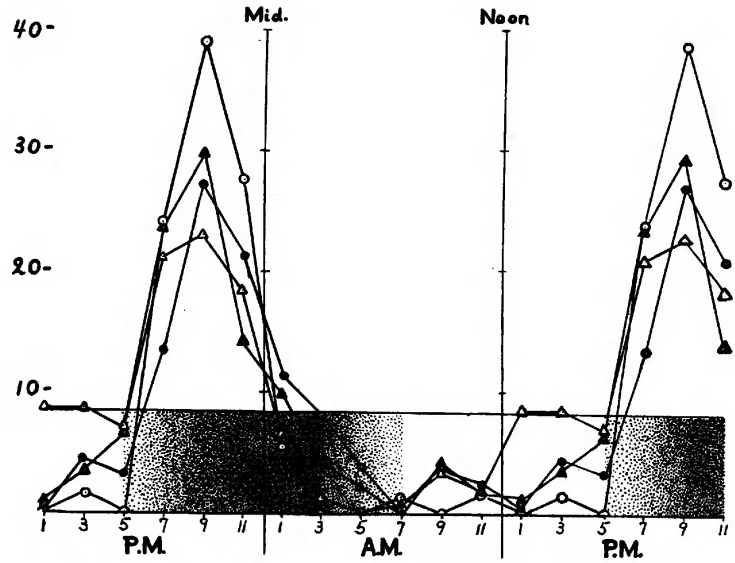

Fig. 1.—Activity Curves of *Gryllus domesticus* in Normal Day-Night Conditions Triangles, males; circles, females; open, immature; solid, mature. See Table 1, 413 G and 420 G.

can calculate the center of distribution of a circular graph but, having done that, it does not seem to be quite as satisfactory as a direct visual comparison of the curves.

Gryllus assimilis

This is the common black Field-cricket of America. Table 2 and figures 6 to 9 show that, like *G. domesticus*, it has a very definite diurnal rhythm that is maintained with no clearly significant change for at least two weeks in constant darkness, temperature, and humidity.

Four experiments (see Table 2 and Figs. 10 to 12) had to do with the effect of "reversed illumination," namely light from 8 P.M. to

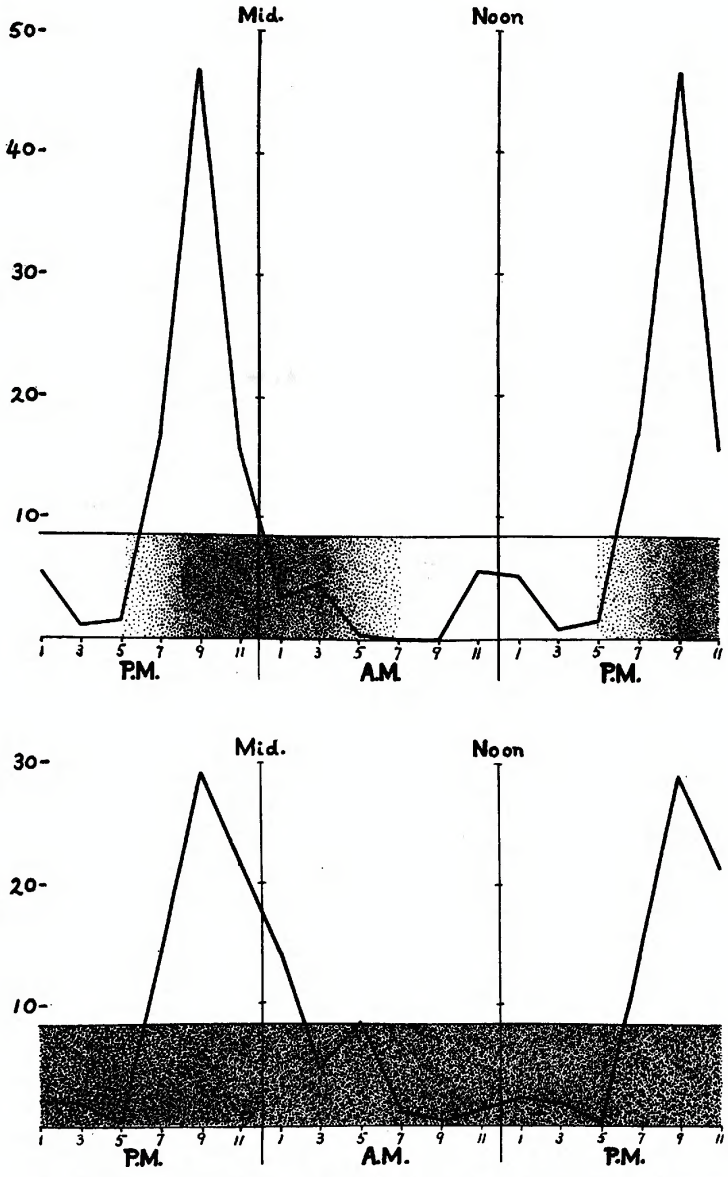

Fig. 2.—Activity Curves of an immature *Gryllus domesticus* in Normal Day-Night Conditions and in subsequent Constant Darkness. See Table 1, 330 G.

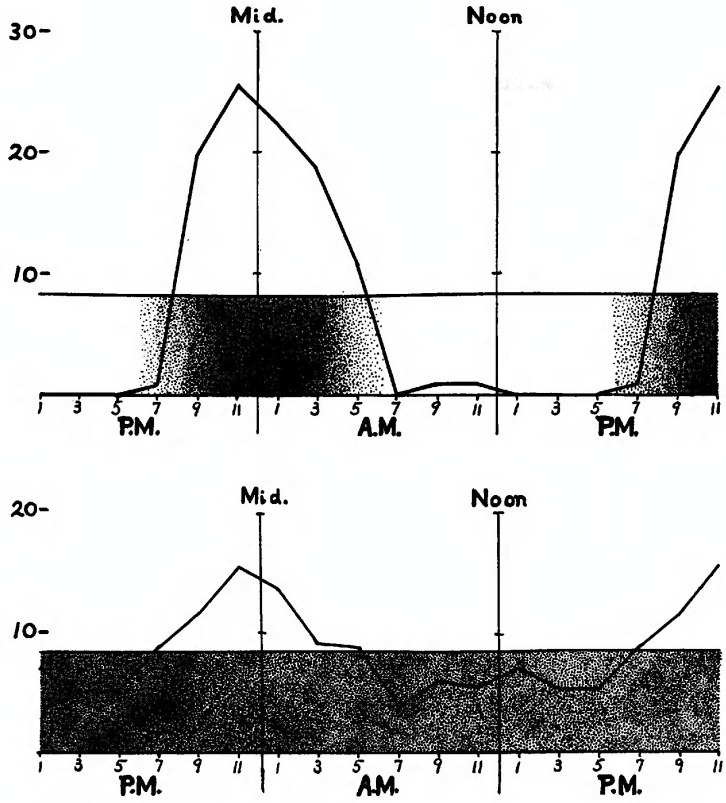

Fig. 3.—Activity Curves of an immature *Gryllus domesticus* in Normal Day-Night Conditions and in subsequent Constant Darkness. See Table 1, 729 G.

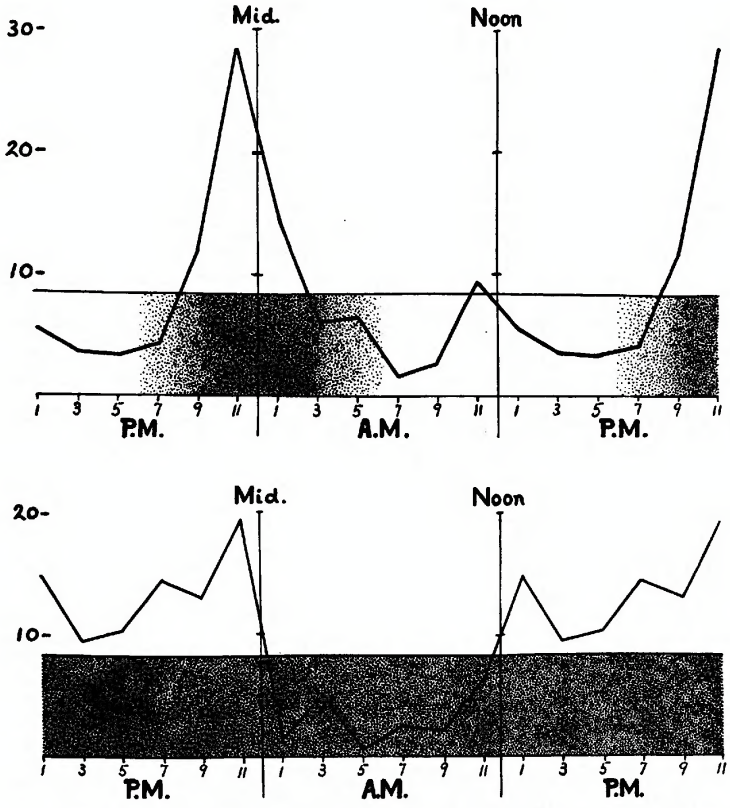

Fig. 4.—Activity Curves of an immature *Gryllus domesticus* in Normal Day-Night Conditions and in subsequent Constant Darkness. See Table 1, 723 G.

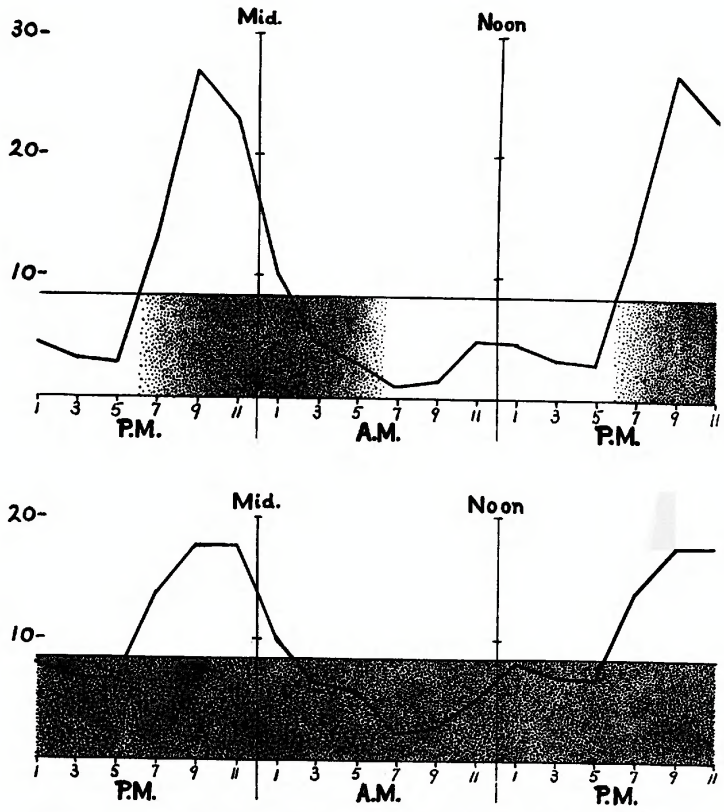

Fig. 5.—Activity Curves, weighted by number of recorded hours, of several immature *Gryllus domesticus* in Normal Day-Night Conditions and in subsequent Constant Darkness. See Table 1, 330 G, 413 G, 729 G, and 723 G.

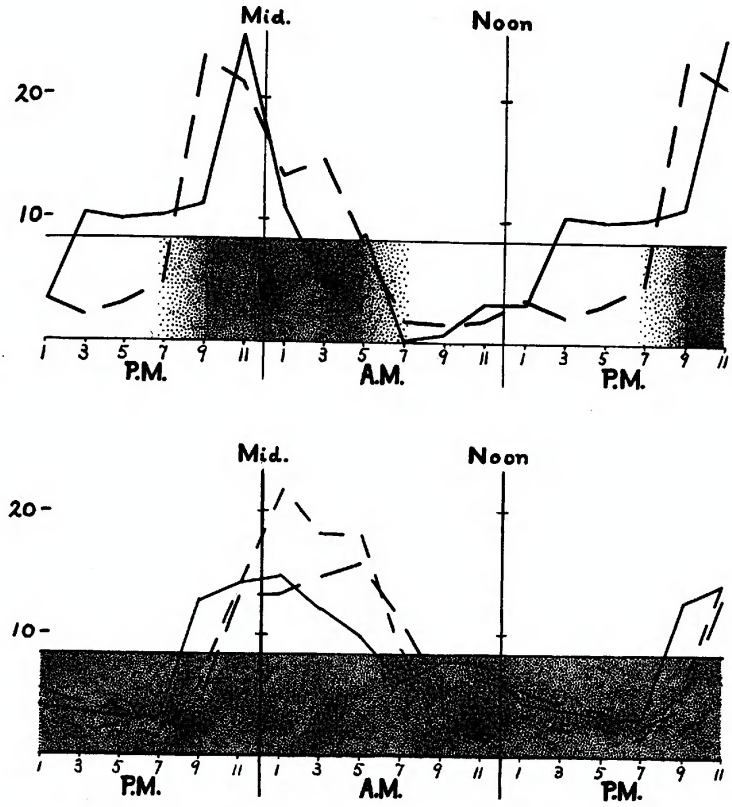

Fig. 6.—Activity Curves of a male *Gryllus assimilis* in Normal Day-Night Conditions and in subsequent Constant Darkness. See Table 2, 829 G1. Solid lines indicate first time-groupings; long dashes, second; and short dashes, third.

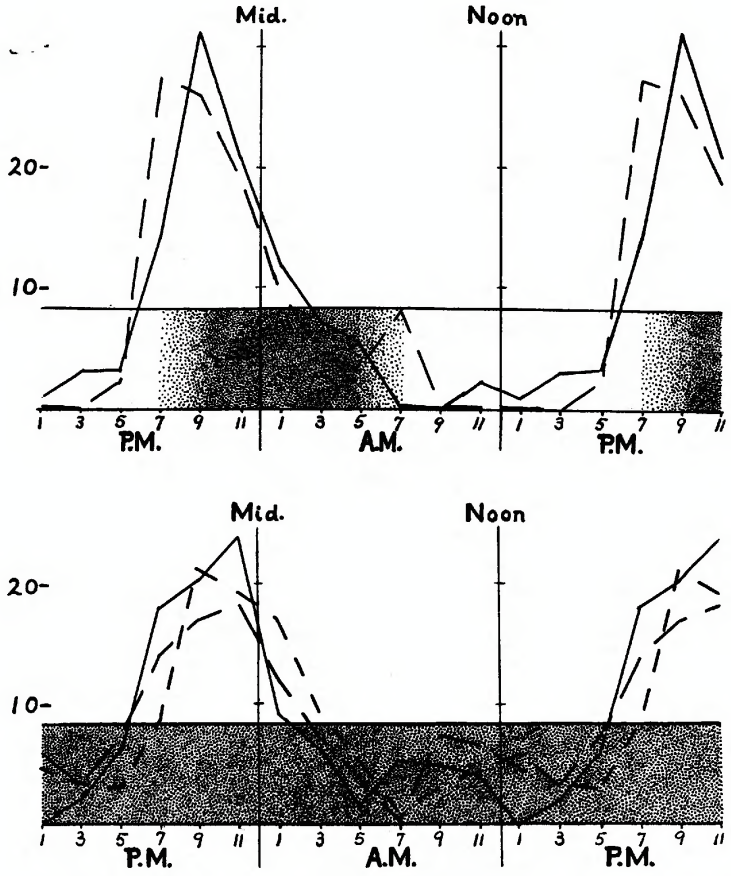

Fig. 7.—Activity Curves of a male *Gryllus assimilis* in Normal Day-Night Conditions and in subsequent Constant Darkness. See Table 2, 829 G2. Solid lines indicate first time-groupings; long dashes, second; and short dashes, third.

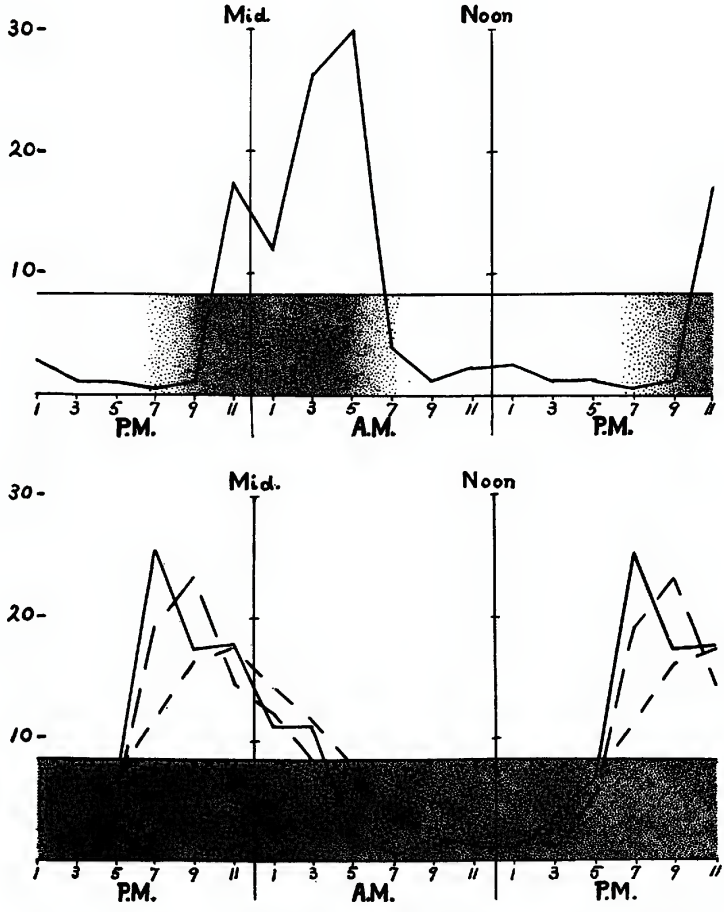

Fig. 8.—Activity Curves of a male *Gryllus assimilis* in Normal Day-Night Conditions and in subsequent Constant Darkness. See Table 2, 910 G1. Solid lines indicate first time-groupings; long dashes, second; and short dashes, third.

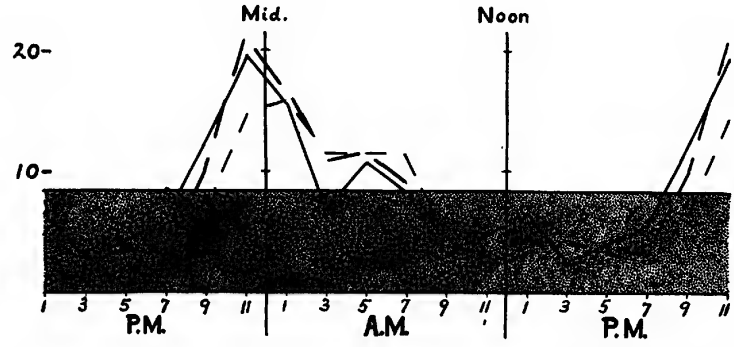

Fig. 9.—Activity Curves of a male *Gryllus assimilis* in Constant Darkness following normal conditions. See Table 2, 914 G1. Solid lines indicate first time-grouping; long dashes, second; and short dashes, third.

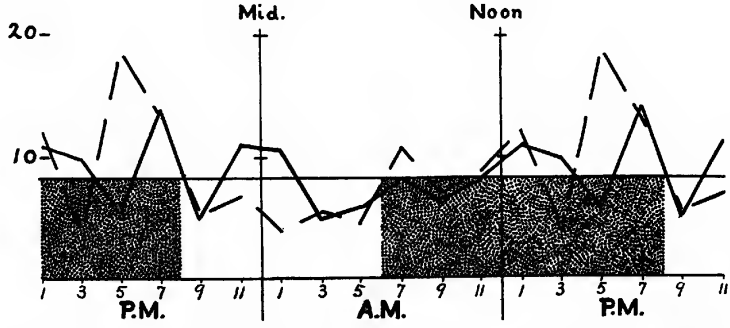

Fig. 10.—Activity Curves of a male *Gryllus assimilis* in "Reversed Illumination" after having been in constant darkness. Solid line indicates the first six days; and the broken line the second. See Table 2, 830 G1.

6 A.M. and darkness during daytime, temperature and humidity being constant.

The male 830 G1 had been in constant darkness for sixteen days (during which time it matured) before it was subjected to reversed illumination and so, were it not for the experiments just mentioned, might have been supposed to have lost some of its normal diurnal rhythm. Unfortunately, we do not have data on this point. Its activities (see

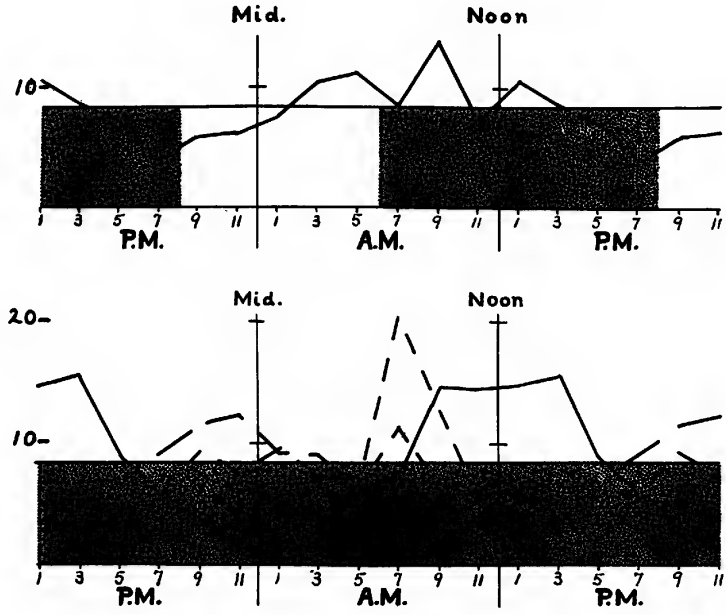

Fig. 11.—Activity Curves of a male *Gryllus assimilis* in "Reversed Illumination" (following normal conditions) and in subsequent Constant Darkness. See Table 2, 905 G1. Solid lines indicate first time-groupings; long dashes, second; and short dashes, third.

Fig. 10) for the first six days of reversed illumination were almost random but with indications of one peak at the normal time near midnight (now light) and another toward the end of the daily period of artificial darkness. In the second six days it had lost its normal peak and increased its new peak.

The males 905 G1 and 906 G1 were transferred directly from normal illumination to reversed. The former male was kept in reversed illumination for five days and the latter for only four. Both (see Figs. 11 and 12) showed a shift of activity peak in this short time. Since the data given

TABLE 2.—CONDENSED STATEMENT OF DATA CONCERNING *GRYLLUS ASSIMILIS*

Experiment	Dates	Light	Average Activity, Per Cent												Average Daily Activity	Number of Hours Recorded
			Noon 2 PM	2 PM 4 PM	4 PM 6 PM	6 PM 8 PM	8 PM 10 PM	10 PM Mid.	Mid. 2 AM	2 AM 4 AM	4 AM 6 AM	6 AM 8 AM	8 AM 10 AM	10 AM Noon		
829 G1 Male	Aug. 29 Sept. 5	N	3.3	10.6	10.0	10.3	11.3	25.2	11.3	4.7	9.0	0.3	0.7	3.3	30.10	152
	Sept. 5 Sept. 12	N	3.4	2.1	3.2	4.9	23.3	21.2	13.6	15.0	8.2	1.9	1.6	1.7	95.50	165
	Sept. 12 Sept. 17	D	4.4	3.7	3.3	3.2	12.8	14.2	14.7	12.1	9.8	6.1	7.9	7.7	113.98	106
	Sept. 17 Sept. 22	D	5.5	4.2	3.8	2.3	4.2	13.1	13.3	14.8	15.9	11.2	5.3	6.3	94.60	120
	Sept. 22 Sept. 27	D	3.6	2.2	2.5	1.4	5.9	14.2	21.7	18.3	18.1	8.8	2.6	0.7	90.98	95
829 G2 Male	Aug. 29 Sept. 5	N	0.9	3.0	3.2	14.4	31.2	20.9	11.8	7.0	5.3	0.2	0.0	2.1	67.56	157
	Sept. 5 Sept. 12	N	0.2	0.0	2.2	27.3	25.8	18.9	9.4	4.4	3.2	8.1	0.2	0.2	57.04	159
	Sept. 12 Sept. 17	D	0.0	2.0	5.9	17.7	20.0	23.6	9.1	6.2	1.5	5.2	4.8	4.2	67.92	96
	Sept. 17 Sept. 22	D	4.6	3.3	7.1	13.8	16.7	18.0	11.7	7.1	3.7	0.2	7.3	6.4	134.48	114
	Sept. 22 Sept. 27	D	5.7	3.3	2.8	8.6	20.9	19.0	16.6	9.2	5.3	1.0	3.0	4.6	126.16	86

830 G1 Male	Aug. 31 Sept. 6	R[1]	10.8	9.7	5.6	13.9	4.9	11.0	10.6	4.7	5.9	8.3	6.3	8.3	74.14	144
	Sept. 6 Sept. 12	R	12.3	3.8	18.8	13.0	5.0	6.9	3.8	5.4	4.6	10.7	6.9	8.8	43.48	144
905 G1 Male	Sept. 7 Sept. 12	R[2]	10.4	8.6	7.0	3.7	5.7	6.3	7.4	10.2	11.2	8.6	13.8	7.3	123.60	120
	Sept. 12 Sept. 16	D	14.6	15.4	8.8	5.8	3.4	2.6	3.6	4.1	5.9	7.2	14.4	14.2	190.38	93
	Sept. 16 Sept. 23	D	6.7	6.4	6.7	8.8	11.3	12.1	9.0	8.8	6.1	11.2	6.5	6.4	172.40	167
	Sept. 23 Sept. 30	D	5.3	5.3	5.4	5.9	9.2	7.4	9.6	7.3	6.9	20.3	12.6	5.0	214.80	168
906 G1 Male	Sept. 8 Sept. 12	R[2]	12.0	5.6	5.2	5.2	2.4	2.8	4.1	7.0	0.8	20.1	20.2	14.5	181.22	93
	Sept. 12 Sept. 16	D	19.3	12.2	9.1	9.7	6.6	6.1	5.6	4.0	1.6	5.5	10.2	10.0	199.58	94
	Sept. 16 Sept. 23	D	2.2	3.2	3.4	7.6	9.8	13.7	18.6	15.0	14.0	4.6	5.0	3.1	209.48	146
	Sept. 23 Sept. 30	D	7.8	2.8	1.9	3.0	2.6	3.9	13.4	24.6	17.1	7.1	7.9	7.9	129.42	167

[1]In constant darkness since Aug. 15, during which time it matured.
[2]Previously in normal light.

910 G1 Male	Sept. 10 Sept. 12	N	2.9	1.2	1.2	0.6	1.2	17.3	12.0	26.3	29.8	4.1	1.2	2.3	171.20	36
	Sept. 12 Sept. 17	D	1.0	3.5	6.7	25.5	17.5	17.8	11.3	11.0	2.3	0.4	1.8	1.2	165.48	100
	Sept. 17 Sept. 22	D	2.5	1.0	5.4	19.2	23.3	14.5	12.0	8.2	6.9	3.8	1.3	1.9	63.40	120
	Sept. 22 Sept. 27	D	1.2	2.6	7.0	11.6	16.3	17.5	14.3	11.4	8.0	3.5	5.0	1.5	99.60	114
914 G1 Male	Sept. 15 Sept. 20	D	6.5	2.6	4.2	5.8	12.2	19.6	15.4	6.9	10.6	8.3	3.2	4.8	37.76	118
	Sept. 20 Sept. 25	D	4.7	2.5	3.5	3.3	10.1	21.1	16.6	10.8	11.4	9.0	3.8	3.2	98.76	107
	Sept. 25 Sept. 30	D	7.0	4.1	3.8	8.4	6.5	14.4	15.7	11.2	11.5	11.3	4.4	1.6	73.78	107
901 G1 Female	Sept. 1 Sept. 12	N	7.9	4.2	7.9	21.7	13.8	14.8	9.5	6.3	6.9	2.1	3.7	1.1	18.90	240
	Sept. 12 Sept. 17	D	12.5	8.2	10.3	1.4	7.6	9.0	14.4	6.1	3.6	10.1	12.0	4.8	69.38	83
	Sept. 17 Sept. 22	D	9.7	8.2	4.1	10.2	6.6	10.2	5.1	7.7	2.6	9.2	14.8	11.7	39.20	120
	Sept. 22 Sept. 27	D	12.8	7.2	5.0	5.6	10.6	11.1	1.7	3.9	10.0	10.5	9.1	12.5	35.92	114

905 G2 Female	Sept. 8 Sept. 12	R	5.3	4.3	10.6	17.6	18.6	12.2	6.4	1.6	2.7	5.3	14.4	1.1	47.06	96
	Sept. 12 Sept. 18	D		Inacti	ve fro	m 9:00	A.M.	Sept.	13 to 5	:00 P.	M. Se	pt. 17				144
	Sept .18 Sept. 24	D	9.4	10.2	10.7	7.2	8.5	17.1	9.0	6.9	2.7	3.1	6.3	8.9	118.00	141
	Sept. 24 Sept. 30	D	6.1	7.9	7.2	8.3	18.7	14.9	7.5	6.7	4.6	4.6	5.0	8.5	104.18	133
905 G3 Female	Sept. 5 Sept. 12	N	13.6	10.7	3.0	10.7	7.2	11.1	8.9	9.8	6.0	6.8	7.7	4.6	33.58	164
	Sept. 12 Sept. 17	D	10.1	7.2	2.1	5.8	12.3	5.1	4.3	7.2	5.1	6.4	11.8	22.6	27.66	102
	Sept. 17 Sept. 22	D	8.3	4.2	0.6	10.1	12.5	13.1	13.7	4.8	7.1	5.4	7.1	13.1	33.60	120
	Sept. 22 Sept. 27	D	11.8	5.9	3.7	5.2	13.3	20.0	8.9	8.9	6.7	3.7	2.8	9.2	27.06	114

are averages for the WHOLE period, the tendency during the first day or two to be active at the normal time accounts for considerable of the activity then. Each was then transferred to constant darkness, temperature, and humidity, where for the first four days each kept true to the newly gained time of activity but then each, particularly 906 G1, went

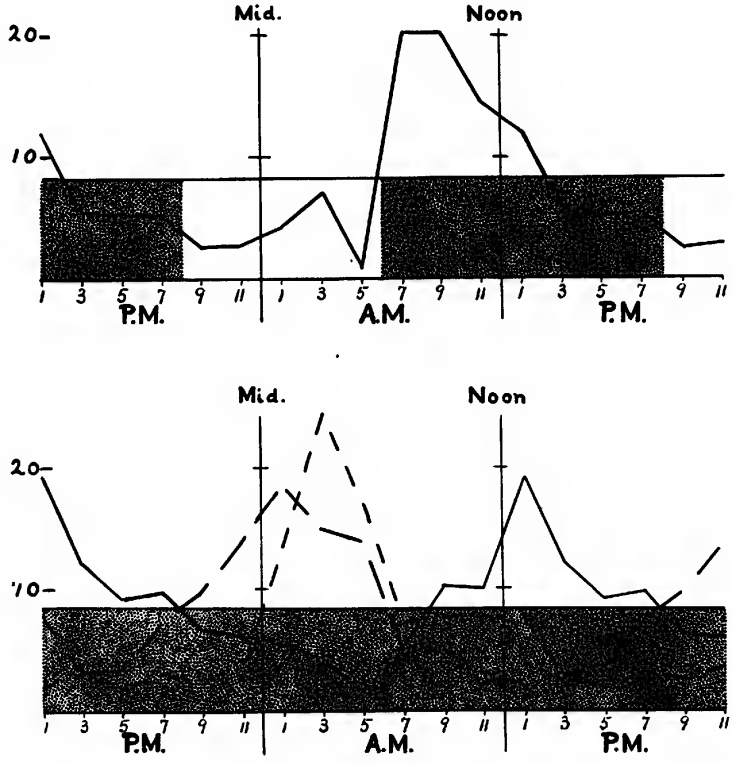

Fig. 12.—Activity Curves of a male *Gryllus assimilis* in "Reversed Illumination" (following normal conditions) and in subsequent Constant Darkness. See Table 2, 906 G1. Solid lines indicate first time-groupings; long dashes, second; and short dashes, third.

back to the old normal time of activity. It may be significant that 906 G1, which had been subjected to reversed illumination for only four days, went back more completely than 905 G1, which had been given five days of reversed illumination and which retained a peak at the time at which the artificial darkness had been begun.

The experiment with a female, 905 G2, was somewhat spoiled by the fact that she was inactive for much of the first five days of darkness

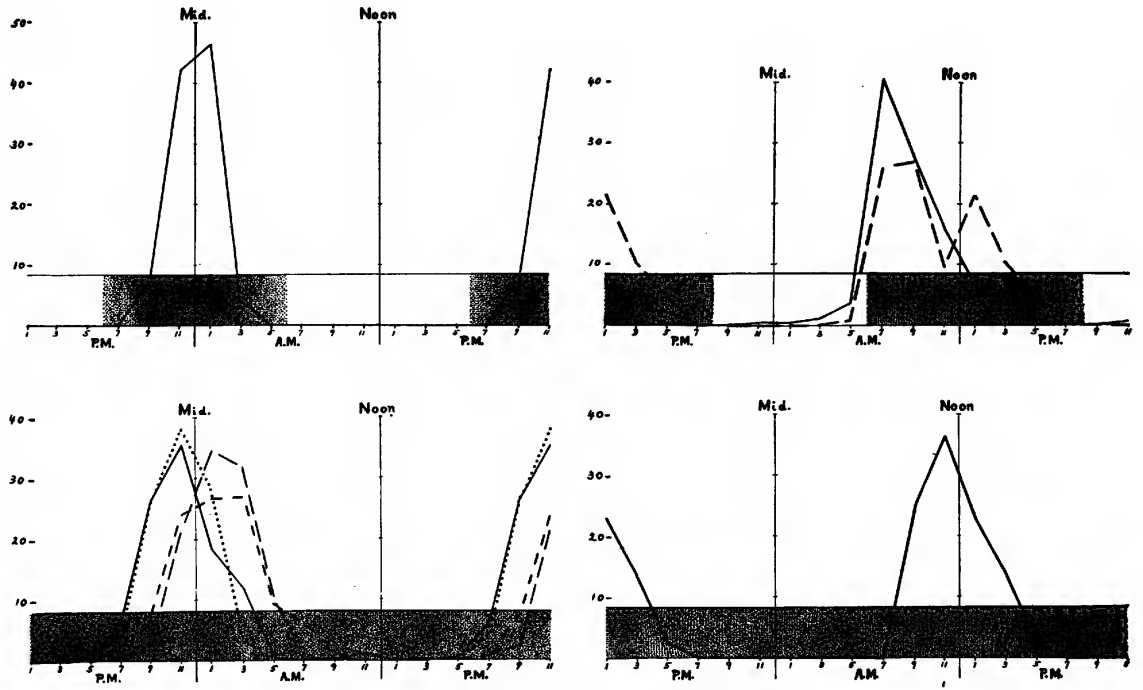

Fig. 13.—Activity Curves of a *Stenopelmatus* in successively Normal Day-Night Conditions, Constant Darkness, "Reversed Illumination," and Constant Darkness. See Table 3, 729 A. Solid lines indicate first time-groupings; long dashes, second; short dashes, third; and dots, fourth.

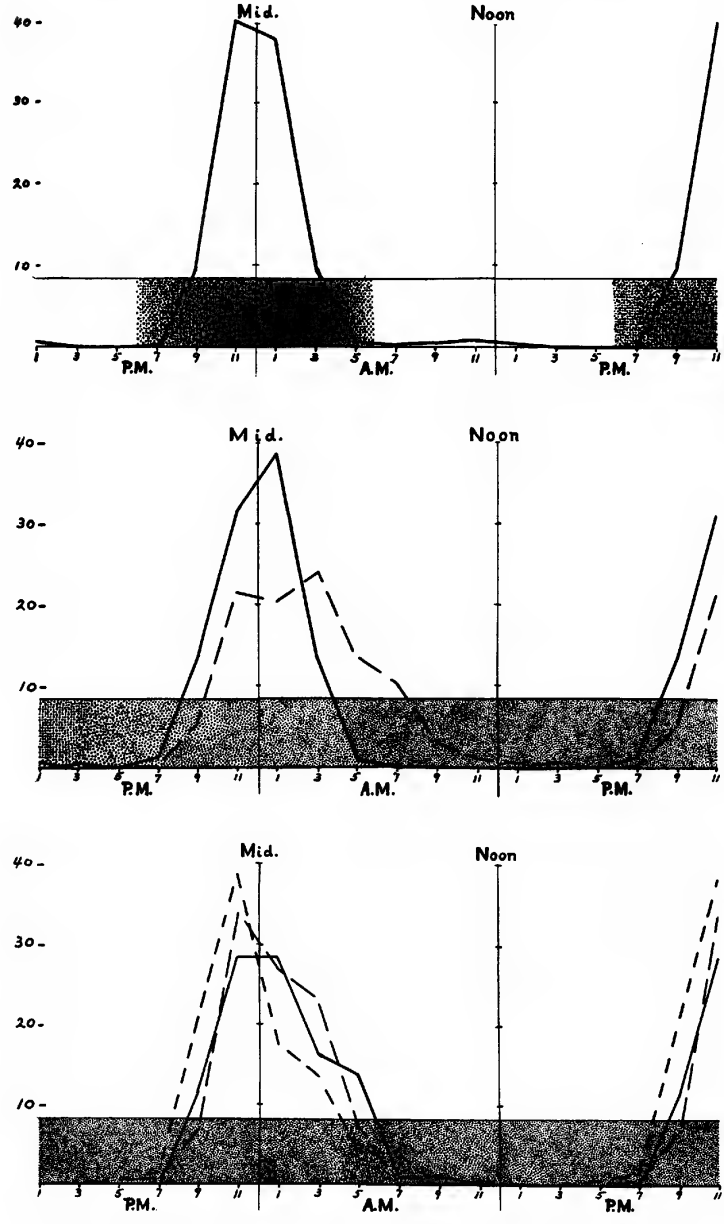

Fig. 14.—Activity Curves of a *Stenopelmatus* in Normal Day-Night Conditions and subsequent Constant Darkness; also Constant Darkness following an inactive period in "Reversed Illumination." See Table 3, 723 S1. Solid lines indicate first time-groupings; long dashes, second; and short dashes, third.

following reversed illumination. However, in this connection see the following experiments with *Stenopelmatus*.

Stenopelmatus

This orthopteron is a wingless, photo-negative "long-horned grasshopper," but during the day and usually during the night also it lives in subterranean burrows. It is a native of southern California, where it is called "Jerusalem Cricket" (although not a cricket) and "Baby Face."

When specimens were brought from the Pacific to the Atlantic coast, using them to study diurnal activity was not anticipated. There is a difference of three hours in standard time at these places and, since the insects had been living for about a month in Eastern Standard Time before they were tested, one can not be certain that the diurnal rhythm shown in table 3 and figures 13 and 14 is not influenced by a previous existence in Pacific Coast Time.

However, it is remarkable that a creature which normally lives in constant darkness should show such a definite diurnal rhythm when subjected to diurnal light-changes, and it seems even more remarkable that such a rhythm should be kept up in subsequent constant darkness.

Much trouble was experienced with these creatures, owing to their dragging earth and food on to the treadle and thus weighting it down with the result that the recording pen was held at the "active" position. As this usually occurred at night and was not remedied until morning, many hours of record were lost. Experiments 723 S1 and S2 were with individuals. There were two individuals in the 729 A cage until August 23, when one of them died.

As in the experiments with the crickets, the compartments at the ends of the cages were made of tin and had a tin cover. Therefore, when the apparatus was in the light these compartments were relatively dark, being illuminated only through the opening connecting with the wire-gauze runway. This fact might be supposed to explain the definite lack of *Stenopelmatus* activity during daylight hours, but it does not explain the continuance of such a marked diurnal rhythm for at least a month of constant darkness, temperature, and humidity.

There is a very interesting, and perhaps significant, comparison to be made between 723 S1 and 729 A when subjected to reversed illumination. Each experiment was with a single individual since one of the two in 729A had died before reversed illumination was started.

Under reversed illumination the 729 A individual shifted its peak of activity from near midnight to the time of mid-day darkness and sub-

TABLE 3.—CONDENSED STATEMENT OF DATA CONCERNING *STENOPELMATUS*

Experiment	Dates	Light	Average Activity, Per Cent												Average Daily Activity	Number of Hours Recorded
			Noon 2 PM	2 PM 4 PM	4 PM 6 PM	6 PM 8 PM	8 PM 10 PM	10 PM Mid.	Mid. 2 AM	2 AM 4 AM	4 AM 6 AM	6 AM 8 AM	8 AM 10 AM	10 AM Noon		
723 S1	July 23 Aug. 1	N	0.4	0.0	0.0	0.0	9.4	40.1	38.1	9.7	0.7	0.2	0.4	0.7	69.62	177
	Aug. 1 Aug. 8	D	0.0	0.4	0.0	1.1	13.6	31.5	38.8	13.9	0.7	0.0	0.0	0.0	39.01	165
	Aug. 8 Aug. 15	D	0.7	0.0	0.1	0.2	5.6	21.6	20.1	23.9	13.7	10.3	2.9	0.8	124.86	168
	Aug. 15 Aug. 30	D				Inacti	ve, ma	king o	nly fiv	e trips						360
	Aug. 30 Sept. 12	R			Pract	ically	inactiv	e, mak	ing onl	y 66 tr	ips					283
	Sept. 12 Sept. 19	D	0.0	0.0	0.0	0.0	11.4	28.5	28.4	16.3	13.6	0.7	1.0	0.0	27.56	150
	Sept. 19 Sept. 25	D	0.0	0.0	0.0	0.5	7.1	33.9	27.2	23.1	7.1	0.0	0.7	0.3	98.32	128
	Sept. 25 Oct. 1	D	0.0	0.0	0.4	1.6	21.1	38.7	17.8	13.5	4.3	2.1	0.0	0.5	40.78	129
723 S2	July 23 Aug. 1	N	2.5	0.0	0.0	3.0	33.4	40.7	12.6	0.2	0.8	3.0	0.3	3.5	61.10[1]	149
	Aug. 1 Aug. 8	D	1.6	3.6	2.0	1.6	4.9	3.3	18.0	57.1	7.9	0.0	0.0	0.0	10.16	136
	Aug. 8 Aug. 15	D	0.0	0.0	0.0	1.7	1.1	34.1	43.2	17.0	0.0	2.2	0.6	0.0	24.68	151

[1]July 26 to 28 omitted because of molting.

729 A	July 29 Aug. 1	N	0.0	0.0	0.0	0.0	7.6	42.0	46.2	4.2	0.0	0.0	0.0	0.0	59.50	46
	Aug. 1 Aug. 8	D	0.0	0.0	0.3	6.2	26.2	35.3	18.4	11.9	0.3	0.0	0.0	1.3	55.00	165
	Aug. 8 Aug. 15	D	0.0	0.0	0.0	0.5	2.3	21.0	34.1	31.5	10.4	0.0	0.2	0.0	73.32	146
	Aug. 15 Aug. 22	D	0.0	0.0	0.0	0.1	7.5	24.0	26.4	26.7	9.3	5.8	0.1	0.0	133.74	156
	Aug. 22 Aug. 30	D	0.0	0.0	0.3	4.2	26.1	37.9	28.0	3.1	0.5	0.0	0.0	0.0	55.45	163
	Aug. 31 Sept. 6	R	6.3	3.2	2.0	0.0	0.0	0.4	0.4	1.2	3.5	40.5	27.2	15.4	42.32	144
	Sept. 6 Sept. 12	R	21.6	10.4	4.8	0.0	0.0	0.0	0.0	0.0	0.8	26.0	26.8	9.6	19.24	142
	Sept. 12 Sept. 18	D	22.9	13.6	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.7	36.2	13.52[1]	142

[1]Very active Sept. 14; practically inactive otherwise and died Sept. 18.

sequently it kept its new peak of activity during six days of constant darkness. Unfortunately, it then died.

The 723 S1 individual became inactive for some unknown reason after two weeks of constant darkness following normal daylight and remained relatively inactive during the twelve days during which it was subjected to reversed illumination. It resumed activity in the subsequent constant darkness, but its peak of activity was that of normal daylight, showing no effect of reversed illumination. This type of diurnal rhythm was kept up to the end of the experiment although that was two months after it had last been subjected to normal daylight and although it had meanwhile been through a period of reversed illumination.

SUMMARY

There seems little to be gained at the present time in doing more than presenting the results of these experiments. Two species of crickets and a subterranean grasshopper showed very definite diurnal rhythms which were continued in constant darkness, temperature, and humidity. These rhythms were changed by "reversed illumination" and then the new rhythms were continued in constant darkness with the following exceptions. The crickets that were subjected to reversed illumination for only a short time showed a tendency to return to the old rhythm after a short time in constant darkness, and the *Stenopelmatus* individual that was inactive during a relatively long period of reversed illumination showed no effect of the reversing when it was subsequently active in constant darkness.